X^e séminaire des utilisateurs et concepteurs du modèle STICS

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LES IMPACTS DU CHANGEMENT CLIMATIQUE SUR LA PRODUCTION DE MAÏS DANS LE CERRADO DU BRESIL

CLIMATE CHANGE IMPACTS ON MAIZE PRODUCTION IN THE CERRADO OF BRAZIL

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Introduction

About 70% of Brazil's farm output is produced in the Cerrado region. The main crops grown are maize, soybean, sugarcane and cotton. The climate is sub-humid tropical, typical of the rather moister savanna regions of the world. Climate model predictions (Torres and Marengo, 2013) suggest that the Cerrado will experience a temperature increase of between 2 °C and 4 °C by the end of the century. Model projections for future rainfall under high emission scenarios indicate a decrease of 20% to 40% of current values. Changes in the distribution of rainfall throughout the year are also expected. These climate changes may have a severe impact on the agricultural sector. There is an urgent need to quantify more securely the risks and uncertainties involved in the effects of climate change on crop production. The objective of this study is to assess the impact of climate change on maize yields in the Cerrado.

Materials and Methods

We used the crop growth model STICS that was calibrated and tested against crop and soil data from an agronomic field trial at the experimental station of Embrapa-Cerrados at Planaltina (15°35’ 30’’ S, 47°42’ 00’’ W, 1175 m asl) (Scopel et al., 2004). Water-limited yields for a typical local maize cultivar were simulated for 12 sowing dates and for two soil types, representing a scenario of low and high plant-available soil water storage capacity, for two sites: Rio Verde (17° 47' S, 50° 55' W, 715 m asl, 1660 mm average rainfall) in the Goiás state and Barreiras (12°09’ S, 44° 59’ W, 452 m asl, 1045 mm average rainfall) in the Bahia state. These sites are representative of the two main subtypes of climate occurring in the Cerrado. The crop growth simulations covered historical climate (1961-1990) and projections for the IPCC A1B emission scenario (2011-2050 and 2051-2100 periods). Climate change projections were generated using the Eta CCS regional climate model nested in the global model HadAM3P (Marengo et al., 2009). Two cropping systems were simulated: maize under conventional tillage and under no-tillage with a mulch of crop residues. Optimal sowing windows were calculated as the interval of sowing dates for which the simulated grain yield is greater or equal to 80% of the maximum yield.

Results and discussion

STICS satisfactorily reproduced the growth and development of maize and the soil water dynamics of the experiment at Planaltina. In general, crop yields under no-tillage with mulching were slightly higher than those under conventional tillage, and also presented a somewhat greater year-to-year yield stability. No-tillage systems use more efficiently the seasonal rainfall as a result of reduced surface water run-off and soil evaporation. Future higher temperatures cause a significant decrease in the growing period of maize (20 days on average) leading to lower total biomass and grain production. Due to future decreased rainfall and increased risk of longer dry spells the sowing windows for maximum yields become smaller, especially at the dryer site Barreiras. At this site, maximum (optimal sowing date) simulated average grain yields decreased from about 7600 kg ha^{-1} under historical climate (1961-1990) to 4400 kg ha^{-1} (2011-2050 period) and 3000 kg ha^{-1} (2051-2100 period). In Rio Verde, average maximum maize grain yields are predicted to drop from 8400 kg ha^{-1} (1961-1990) to 7800 kg ha^{-1} (2011-2050 period) and 6200 kg ha^{-1} (2051-2100 period).

Conclusions

Our model simulations predict severe impacts of climate change on crop production in the Cerrados, *especially* in the dryer regions. Effective strategies are needed to adapt to climate change, which should concentrate on the impact of higher temperatures and more erratic rainfall on lowering crop yields. Such strategies include breeding and using more drought tolerant crops with a phenology that better matches to the new environmental conditions. In terms of management options available to farmers, strategies that preserve soil moisture, such as no-tillage with mulching, should become more important. Use of seasonal climate forecasts can help farmers with better identifying optimal sowing dates and can also play an important role in reducing production risks due to rainfall variability.

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